

What is claimed is:

1. A timing error detection circuit for detecting a timing error of symbols arranged at a predetermined symbol cycle included in a signal, comprising:

a sampling circuit for sampling said signal at a frequency equal to or more than double of a symbol rate;

an amplitude detection circuit for detecting an amplitude at said sampled position in said signal; and

a detection circuit for detecting said timing error based on difference of said detected plurality of amplitudes.

2. A timing error detection circuit as set forth in claim 1, wherein said signal is a phase shift modulated signal.

3. A timing error detection circuit for detecting a timing error of symbols arranged at a predetermined symbol cycle  $T$  included in a signal, comprising:

a sampling circuit for sampling said signal at a frequency equal to four times of a symbol rate;

an amplitude detection circuit for detecting an amplitude at said sampled position in said signal; and

a detection circuit for detecting a direction

and amount of said timing error based on the large or small relationship and the difference of said detected amplitude at time " $T/4$ " and the detected amplitude at time " $3T/4$ " when assuming a symbol appears at times "0" and " $T$ ".

4. A timing error detection circuit as set forth in claim 3, wherein said signal is a phase shift modulated signal.

5. A timing error detection circuit for detecting a timing error of symbols arranged at a predetermined symbol cycle  $T$  included in a signal, comprising:

a sampling circuit for sampling at a frequency equal to double of a symbol rate;

an interpolation circuit for generating data at time " $T/4$ " by using sampled data at time "0" and " $T/2$ ", and generating data at time " $3T/4$ " by using said sampled data at time " $T/2$ " and data on time " $T$ " when assuming a symbol appears at times "0" and " $T$ ";

an amplitude detection circuit for detecting an amplitude of said signal at the position from data at said time " $T/4$ " and time " $3T/4$ "; and

a detection circuit for detecting a direction and amount of said timing error based on the large or small relationship and the difference of the amplitude at

said time " $T/4$ " and the amplitude at said time " $3T/4$ ".

6. A timing error detection circuit as set forth in claim 5, wherein said signal is a phase shift modulated signal.

5 7. A demodulation circuit, comprising:

a symbol timing reproduction circuit for detecting a timing error of symbols arranged at a predetermined symbol cycle included in a signal and reproducing a symbol timing of said signal based on the detected timing error;

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a carrier reproduction circuit for performing carrier reproduction of the signal wherein said symbol timing is reproduced; and

a symbol decode circuit for decoding said symbol included in said carrier reproduced signal;

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and wherein:

said symbol timing reproduction circuit comprises:

a sampling circuit for sampling said signal at a frequency equal to or more than double of a symbol rate or more;

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an amplitude detection circuit for detecting an amplitude at said sampled position in said signal;

a detection circuit for detecting said timing error based on difference of said detected plurality of

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amplitudes; and

an interpolation circuit for reproducing the symbol timing by performing interpolation processing on said signal based on said detected timing error.

5           8.     A demodulation circuit as set forth in claim 7, wherein said signal is a phase shift modulated signal.

9.     A demodulation circuit, comprising:

10           a symbol timing reproduction circuit for detecting a timing error of symbols arranged at a predetermined symbol cycle included in a signal and reproducing a symbol timing of said signal based on the detected timing error;

15           a carrier reproduction circuit for performing carrier reproduction of the signal wherein said symbol timing is reproduced; and

          a symbol decode circuit for decoding said symbol included in said carrier reproduced signal:

          and wherein:

20           said symbol timing reproduction circuit comprises:

          a sampling circuit for sampling said signal at a frequency equal to four times of a symbol rate;

          an amplitude detection circuit for detecting an amplitude at said sampled position in said signal;

25           a detection circuit for detecting a direction

and amount of said timing error based on sizes and difference of said detected amplitude at time " $T/4$ " and the detected amplitude at time " $3T/4$ " when assuming a symbol appears at times "0" and " $T$ "; and

5                   an interpolation circuit for reproducing the symbol timing by performing interpolation processing on said signal based on said detected timing error.

10.    A demodulation circuit as set forth in claim 9, wherein said signal is a phase shift modulated signal.

10           11.    A demodulation circuit, comprising:  
              a symbol timing reproduction circuit for detecting a timing error of symbols arranged at a predetermined symbol cycle included in a signal and reproducing a symbol a symbol timing of said signal based on the detected timing error;

15                   a carrier reproduction circuit for performing carrier reproduction of the signal wherein said symbol timing was reproduced; and

20                   a symbol decode circuit for decoding said symbol included in said carrier reproduced signal;

              and wherein:

              said symbol timing reproduction circuit comprises:

25                   a sampling circuit for sampling said signal at a frequency equal to double of a symbol rate;

a first interpolation circuit for generating data at time " $T/4$ " by using said sampled data at time "0" and " $T/2$ ", and generating data at time " $3T/4$ " by using said sampled data at time " $T/2$ " and data at time " $T$ " when assuming a symbol appears at times "0" and " $T$ ";

an amplitude detection circuit for detecting an amplitude of said signal at the position from data on said time " $T/4$ " and data at said time " $3T/4$ ";

a detection circuit for detecting a direction and amount of said timing error based on the large or small relationship and the difference of an amplitude at said time " $T/4$ " and an amplitude at said time " $3T/4$ "; and

a second interpolation circuit for reproducing a symbol timing by performing interpolation processing on said signal based on said detected timing error.

12. A demodulation circuit as set forth in claim 11, wherein said signal is a phase shift modulated signal.

13. A timing error detection method for detecting a timing error of symbols arranged at a predetermined symbol cycle included in a signal, comprising the steps of:

sampling said signal at a frequency equal to or more than double of a symbol rate;

detecting an amplitude at said sampled position in said signal; and

detecting said timing error based on difference of said detected plurality of amplitudes.

5           14. A timing error detection method as set forth in claim 13, wherein said signal is a signal subjected to phase shift modulation.

10           15. A timing error detection method for detecting a timing error of symbols arranged at a predetermined symbol cycle  $T$  included in a signal, including the steps of:

sampling said signal at a frequency of four times a symbol rate;

15           detecting an amplitude at said sampled position in said signal; and

20           detecting a direction and size of said timing error based on sizes and difference of said detected amplitude at time " $T/4$ " and the detected amplitude at time " $3T/4$ " when assuming a symbol appears at times " $0$ " and " $T$ ".

16. A timing error detection method as set forth in claim 15, wherein said signal is a phase shift modulated signal.

25           17. A timing error detection method for detecting a timing error of symbols arranged at a predetermined

symbol cycle  $T$  included in a signal, including the steps of:

sampling at a frequency equal to double of a symbol rate;

5 generating data at time " $T/4$ " by using said sampled data at time " $0$ " and data at time " $T/2$ " when assuming a symbol appears at times " $0$ " and " $T$ ";

generating data at time " $3T/4$ " by using said sampled data at time " $T/2$ " and data on time " $T$ ";

10 detecting an amplitude of said signal at the position from data at said time " $T/4$ " and time " $3T/4$ "; and

detecting a direction and size of said timing error based on the large or small relationship and the difference of the amplitude at said time " $T/4$ " and the amplitude at said time " $3T/4$ ".

18. A timing error detection method as set forth in claim 17, wherein said signal is a signal subjected to phase shift modulation.

20 19. A modulation method including the steps of:

sampling said signal at a frequency equal to double of twice a symbol rate;

detecting an amplitude at said sampled position in said signal;

25 detecting said timing error based on



difference of said detected plurality of amplitudes;

reproducing a symbol timing by performing interpolation processing on said signal based on the detected timing error;

5 performing carrier reproduction of the signal wherein said symbol timing is reproduced; and

decoding said symbol included in said carrier reproduced signal.

20. A demodulation method as set forth in claim 10 19, wherein said signal is a phase shift modulated signal.

21. A demodulation method, including the steps of:

15 sampling said signal including symbols arranged at a predetermined symbol cycle at a frequency equal to four times of a symbol rate;

detecting an amplitude at said sampled position in said signal;

20 detecting a direction and size of said timing error based on the large or small relationship and the difference of said detected amplitude at time " $T/4$ " and said detected amplitude at time " $3T/4$ " when assuming a symbol appears at times " $0$ " and " $T$ ";

25 reproducing a symbol timing by performing interpolation processing on said signal based on said

detected timing error;

performing carrier reproduction of the signal  
wherein said symbol timing is reproduced; and

decoding said symbol included in said carrier  
reproduced signal.

22. A demodulation method as set forth in claim  
21, wherein said signal is a phase shift modulated  
signal.

23. A demodulation method including the steps of:  
sampling a signal including symbols arranged  
at a predetermined symbol cycle at a frequency equal to  
double of a symbol rate;

generating data at time " $T/4$ " by using said  
sampled data at time " $0$ " and data at time " $T/2$ " when  
assuming a symbol appears at times " $0$ " and " $T$ ";

generating data at time " $3T/4$ " by using said  
sampled data at time " $T/2$ " and data at time " $T$ ";

detecting an amplitude of said signal at the  
position from data at said time " $T/4$ " and data at time  
" $3T/4$ "; and

detecting a direction and amount of said  
timing error based on the large and small relationship  
and difference of the amplitude of said time " $T/4$ " and  
the amplitude at said time " $3T/4$ ";

reproducing the symbol timing by performing

interpolation processing on said signal based on said detected timing error;

performing carrier reproduction of the signal wherein said symbol timing is reproduced; and

5 decoding said symbol included in said carrier reproduced signal.

24. A demodulation method as set forth in claim 23, wherein said signal is a signal subjected to phase shift modulation.